Operative Techniques in
Thoracic and
Cardiovascular Surgery

Aortic Valve Replacement with the Medtronic Freestyle Xenograft Using the Subcoronary Implantation Technique

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The stentless bioprosthesis has many salient features that make it an attractive option for aortic valve replacement. It has excellent hemodynamic properties, does not require that the patient have anticoagulation, is readily available off the shelf, and is versatile, so it can be used in many pathologic conditions as a valve or a root conduit. Accordingly, it is our prosthesis of choice in most circumstances. It is our observation that the improved hemodynamics, even early postoperatively, offset any concern about the increased operative risk due to complexity of the implantation. This article describes our technique for implantation of the stentless prosthesis in a modified subcoronary position to be used in patients with valvular disease and normal sinuses of Valsalva.

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Operative Techniques

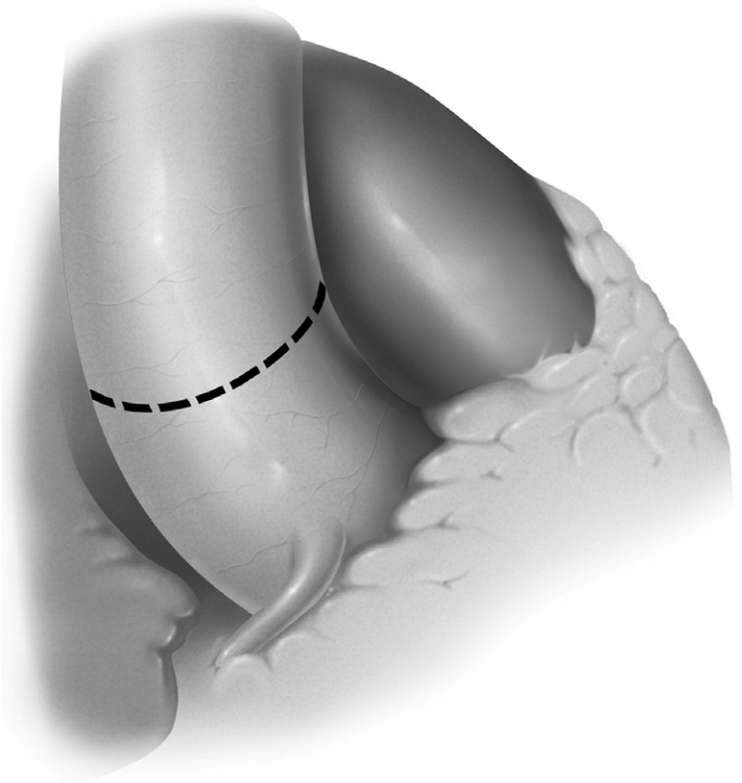


Figure 1 A transverse aortotomy is performed preferentially. The aorta is partially transected 1.5 to 2 cm above the right coronary artery. Looking inside the aorta, the incision is extended 1.5 to 2 cm above the left coronary ostium and to the right, ending 1.5 to 2 cm above the left noncoronary commissural post.

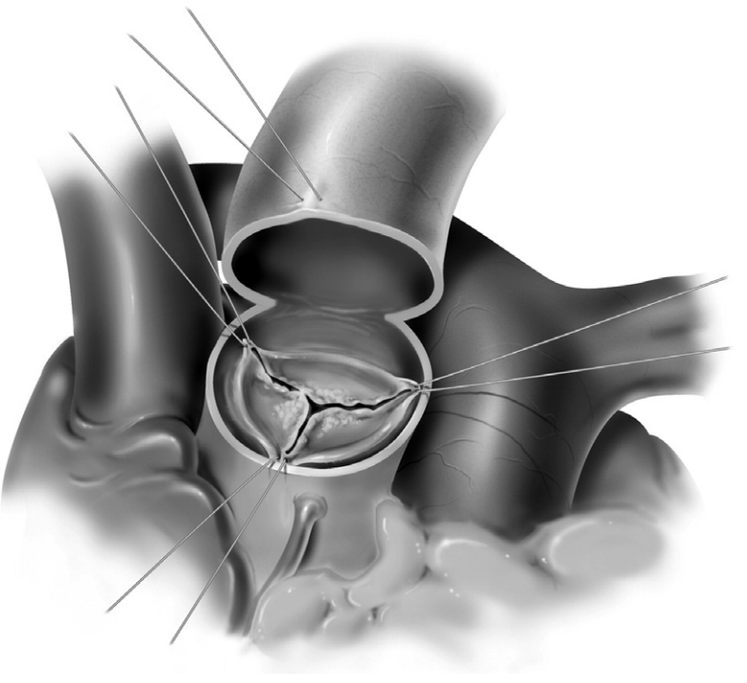


Figure 2 Optimal visualization of the aorta is obtained by placing stay sutures at the tops of the commissures. This procedure holds back the edges of the ascending aorta, permitting one to inspect the pathologic condition of the valves and determine the symmetry and number of commissures present, which is important for lining up the new prosthesis.

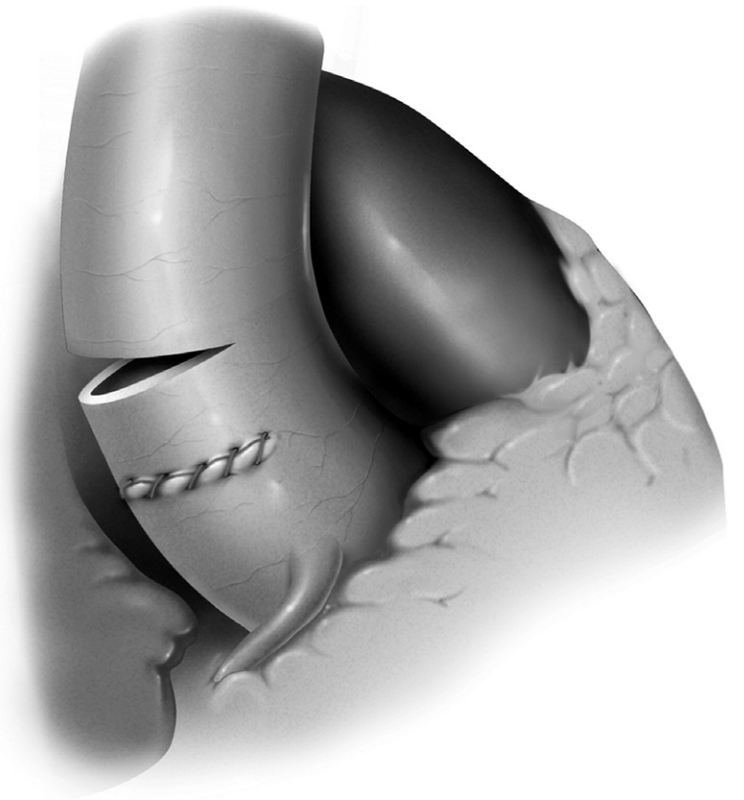


Figure 3 On occasion, one discovers that this aortotomy is a bit too low to permit implantation of the Medtronic Freestyle stentless xenograft in the subcoronary position. The aortotomy can be repaired in a straightforward manner as shown in this figure, and a second more distal transverse aortotomy can be made as desired.

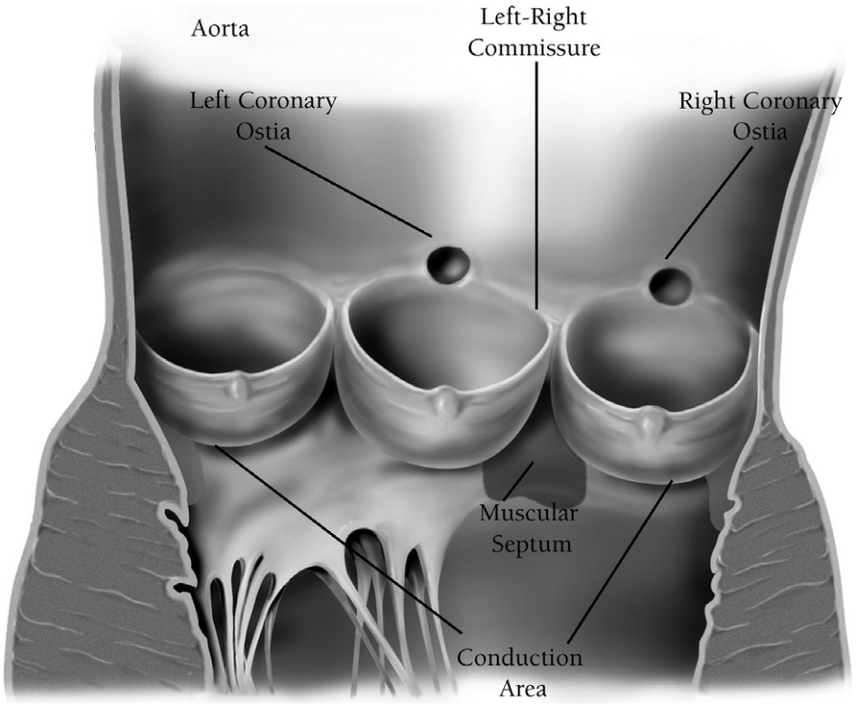


Figure 4 The anatomy of the patient's aortic valve must be defined after completely excising the diseased valve leaflets and debriding the annulus and aortic wall of calcium. The patient's left–right commissure is used as the reference point for implantation of the new valve. The height of the coronary artery ostia above the surgical annulus and their relationship to the commissures should be noted. If calcification of the aortic wall underneath the coronary ostia is extensive, it may be necessary to implant the bioprosthesis using a full root technique. If the calcium is limited to the annulus, however, or to other areas of the aortic wall, sutures can be taken completely through the Freestyle bioprosthesis and native aortic wall for the subcoronary technique.

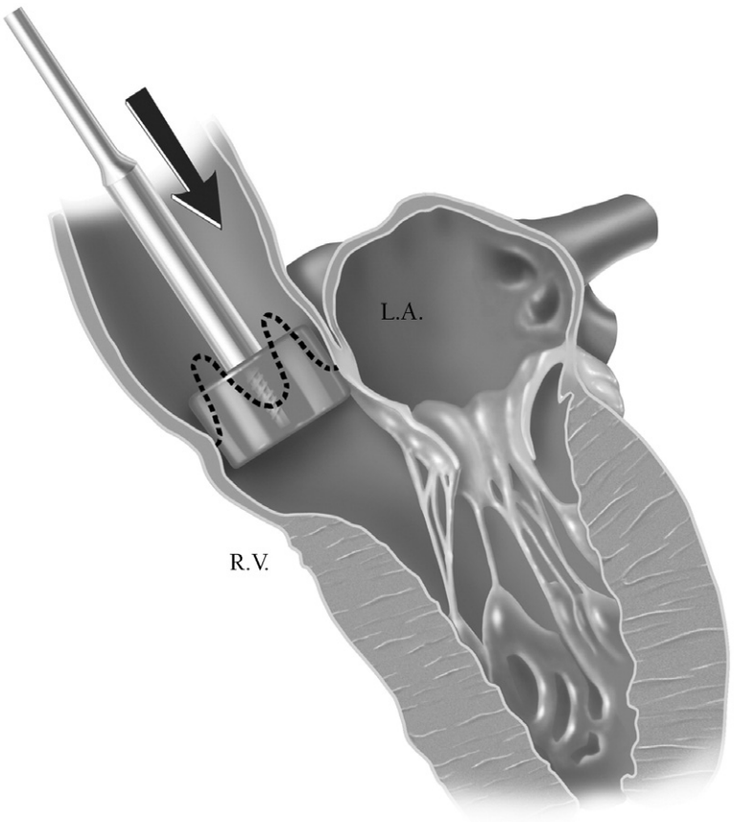


Figure 5 The appropriate-size valve is determined by placing the sizer at the plane of implantation, which is at the lowest level (nadir) of the surgical annulus.

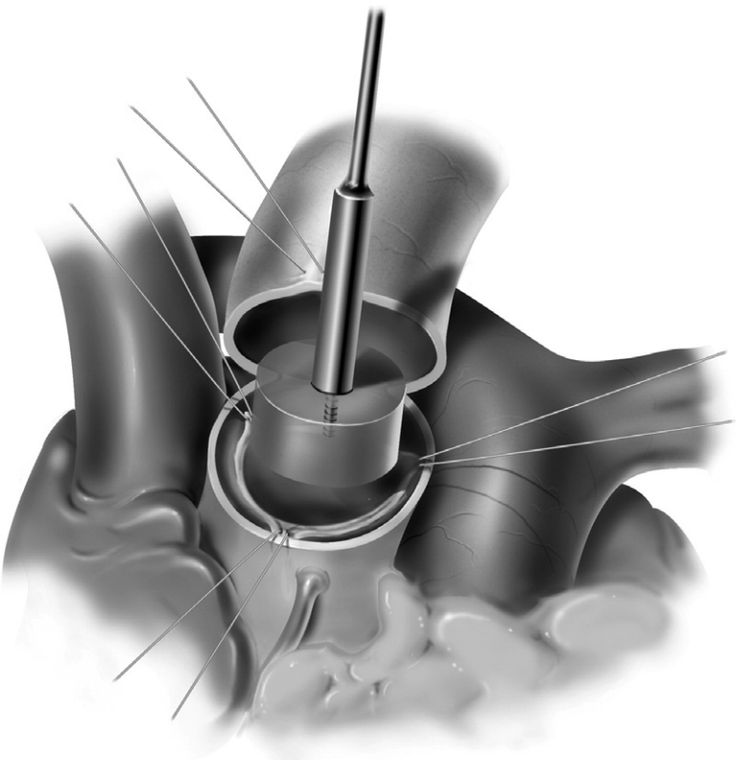
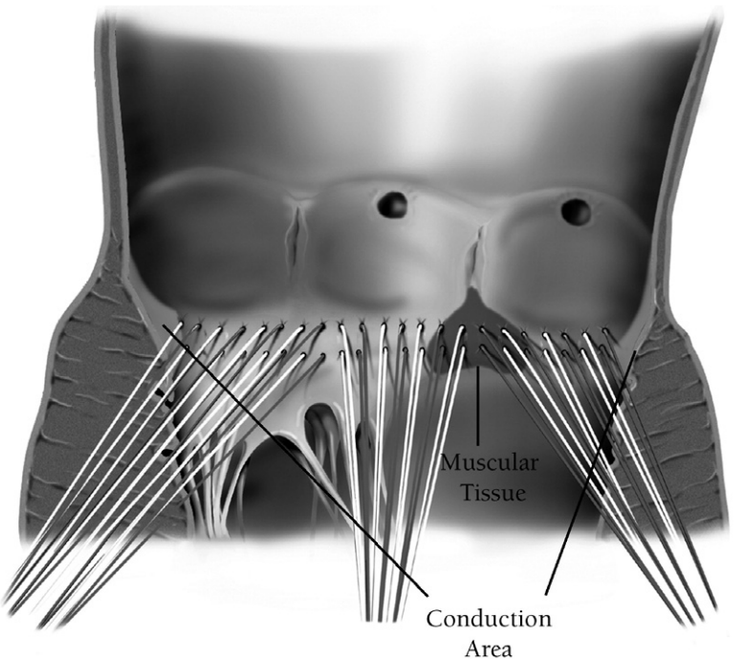


Figure 6 The Freestyle sizer need not pass through the annulus into the ventricle but need only sit on the nadir of the three cusps without impinging on the sinus tissue. The valve should not be undersized when implanted in the subcoronary position. After the appropriate valve size is chosen, the Freestyle bioprosthesis may be rinsed while the inflow suture line is placed. If the annulus is larger than the largest available Freestyle bioprosthesis, the annulus may be plicated to accommodate the valve. This is accomplished by placing U stitches at the level of the aortoventricular junction below the commissures. These sutures may be tied down with the appropriate-size Freestyle valve sizer in place to assure appropriate dimensions. If the sinotubular junction is more than 2 mm larger than the patient's annulus, consideration should be made to implant the prosthesis as a freestanding root or using the inclusion root technique.

Figure 7 The inflow sutures are placed using the patient's left-to-right commissure as the reference point of origin. Starting there, 2-0 braided polyester sutures are placed in a simple fashion in the horizontal plane based on the level of the nadir of the annulus (at the aortoventricular junction). These sutures should be placed in the muscle below the left–right commissure and in the fibrous tissue and valvular tissue below the right-noncommissures and left-noncommissures. Sutures should be placed 2 to 3 mm apart starting at the level of the annulus in the muscular tissue below the left–right commissure. Do not attempt to align the Freestyle valve commissures with the patient's native commissures unless the patient's commissures are perfectly symmetrical. Suture-needle guides can be used to keep sutures organized. Place the bottom inflow stitch in the B location and then use that inflow needle to put the stitch through the bioprosthesis. Sutures placed in the muscle below the left–right commissure should be generous bites because muscle tissue is friable and prone to tearing. Sutures placed in the conduction area may be shallow because this tissue is fibrous.



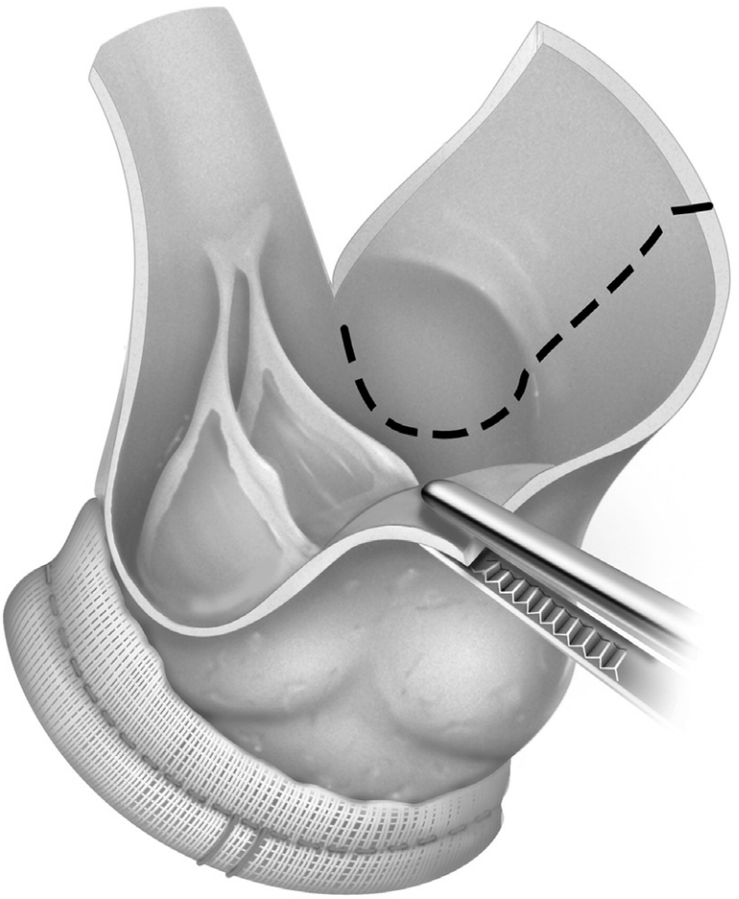


Figure 8 Before implanting the Freestyle bioprosthesis, it is important to determine whether the valve can be implanted with the prosthesis coronary sinuses corresponding anatomically to the patient's coronary sinuses or if it will be necessary to rotate the valve. If the valve is to be implanted orthotopically, the left and right sinuses of the valve are excised with a millimeter margin of Freestyle aortic wall remaining along the leaflet tissue and commissural posts to allow for adequate suturing. Alternatively, the Freestyle bioprosthesis can be trimmed after it is seated.

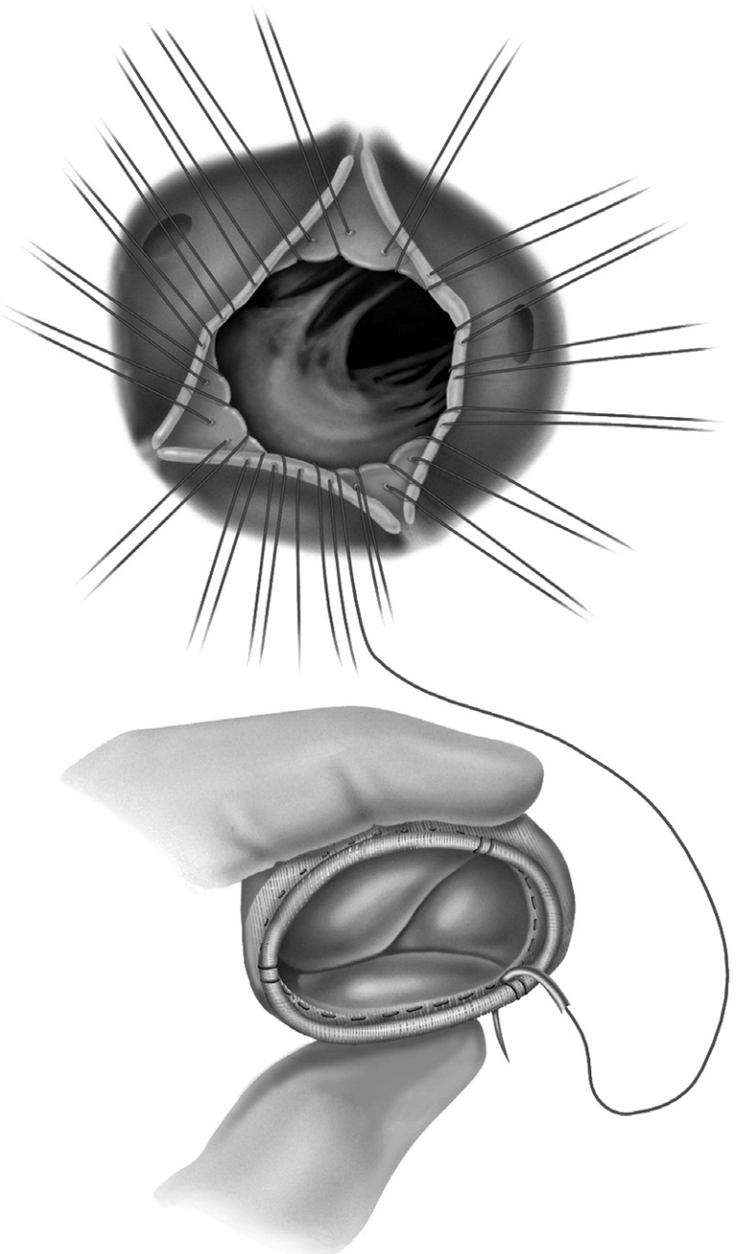


Figure 9 The valve sutures are placed starting at the left-to-right commissure, dividing the sutures in equal thirds. The first stitch in each third will then be placed through the inflow suture cuff of the Freestyle prosthesis at the point corresponding to the bioprosthesis commissure, indicated by the double green solid vertical markers on the sewing cuff. This process aligns the Freestyle bioprosthesis symmetrically for implantation, independent of the location of the patient's commissures. The green horizontal line at the inflow edge of the bioprosthesis indicates the area for suture placement. Do not place sutures above the dotted green line. The remaining sutures are placed evenly between the respective commissures. Begin tying the noncoronary sinus sutures and continue around the annulus.

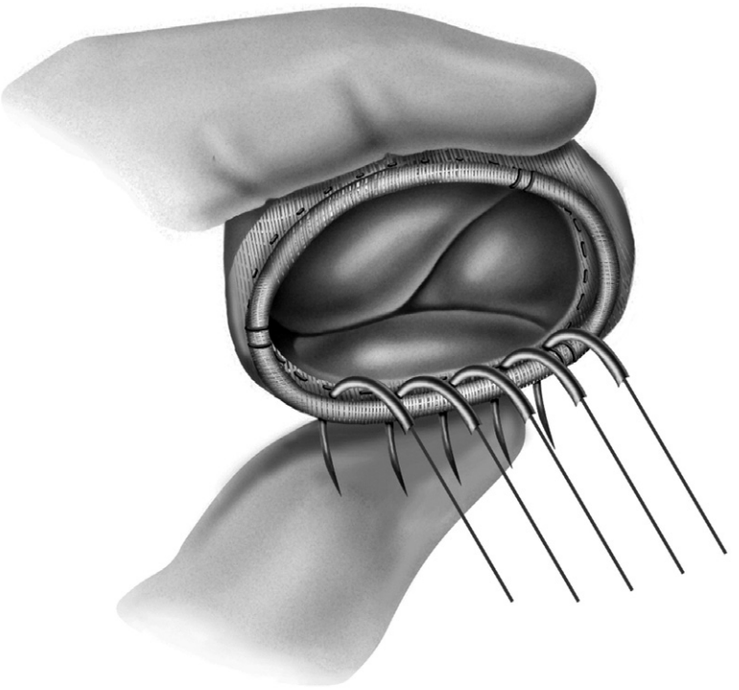


Figure 10 When placing a stitch through the sewing cuff, do not completely pass the needle through the cuff until all sutures between the two commissures have been inserted and even spacing has been confirmed. This allows for easy repositioning of sutures if spacing appears uneven. Leave the sutures in the muscle under the left–right commissure to be tied last, because this tissue is the most friable, and knots will be more secure if the valve is seated by the other sutures first.

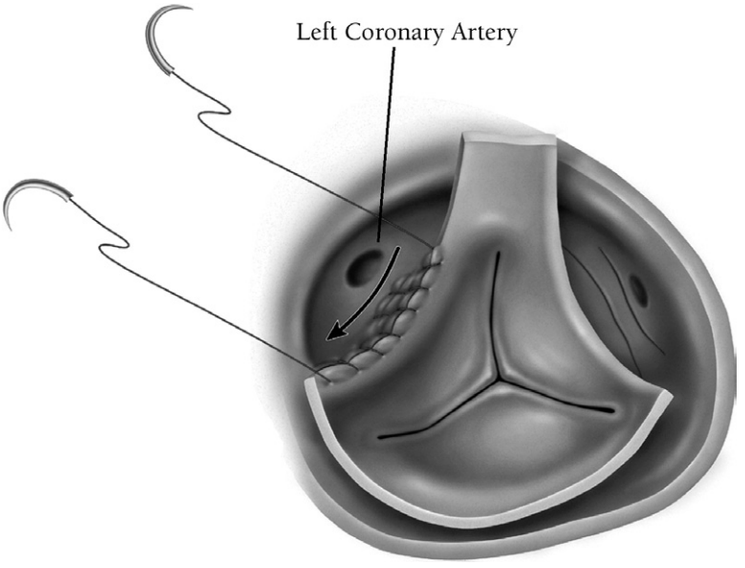


Figure 11 The outflow suture line is performed with a running technique using a double-armed 4-0 polypropylene suture. The suture line is begun at the left coronary sinus starting half the distance up the left–right commissural post. Using the rim of tissue that remains on the Freestyle valve, run the suture line up to the top of the left-noncoronary commissure. Complete the suture line to the top of the left–right commissural post.

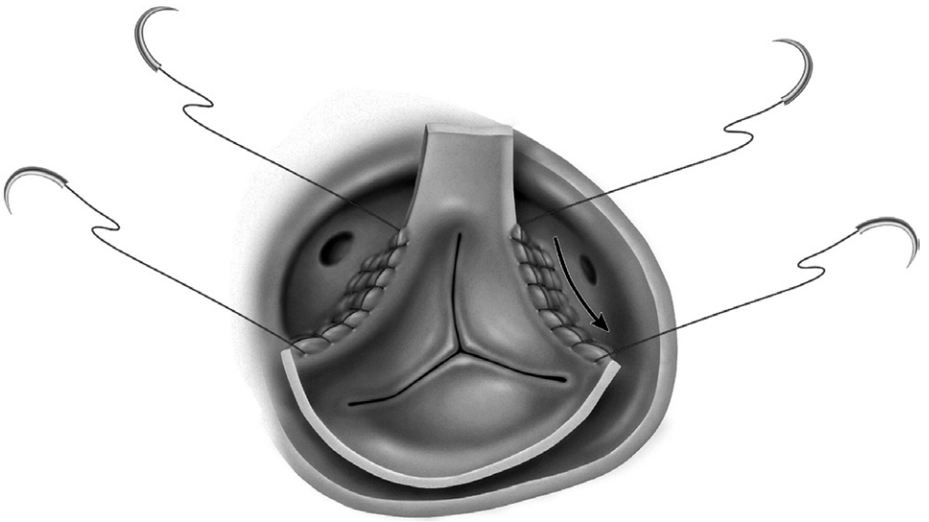


Figure 12 The subcoronary suture line under the right coronary ostia is performed as a mirror image of the previous suture line. Note that the larger area of the polyester covering on the Freestyle bioprosthesis is below this suture line. When running this suture line under the coronary arteries, make sure that the needle does not exit in the openings. Place the first three to four stitches backhand with a needle holder placed proximally on the needle to create a sharp arch. Do not tack the Freestyle commissures to the patient's aorta with stay sutures because it is important to be able to move the distal end of the bioprosthesis to facilitate exposure. An assistant may pull up on the patient's aorta and move the left–right post to the side to facilitate running sutures under the coronary ostium.

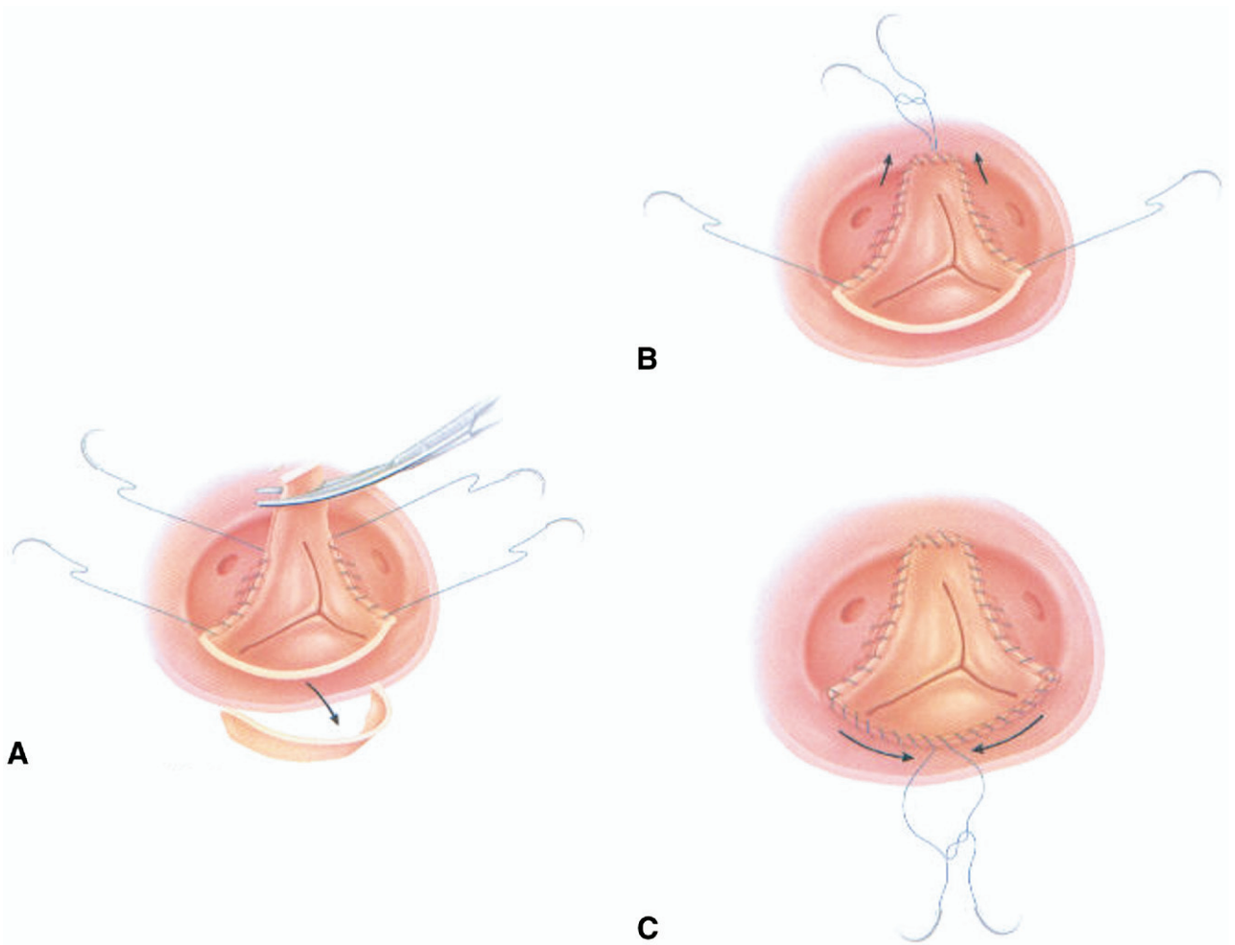


Figure 13 (A-C) The remaining prosthetic tissue can then be trimmed to size, matching the height of the noncoronary sinus of the prosthesis to the height of the noncoronary sinus of the patient. The tails of the 4-0 suture used in the subcoronary suture lines beneath the right and left coronary ostia are then continued across the top of the noncoronary sinus to complete the suture line. The aortotomy is then closed in the usual manner.

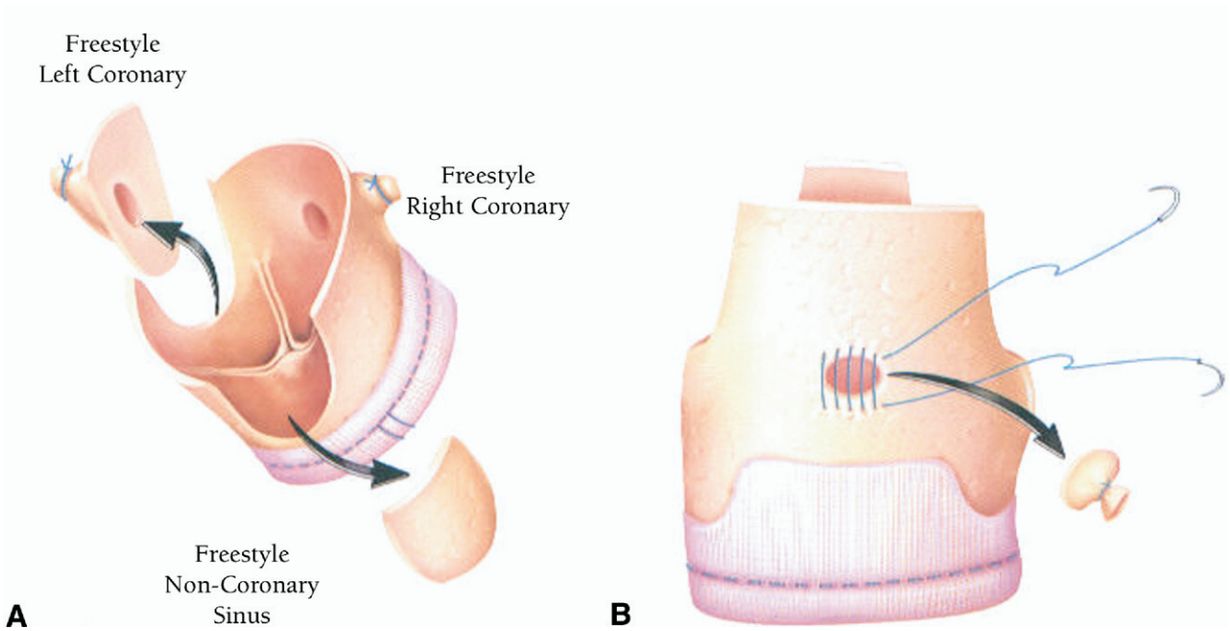


Figure 14 (A, B) In some situations the Freestyle bioprosthesis may need to be rotated 120°. This is particularly relevant when one has a normal-size root with a relatively low right coronary artery. Recall that the larger area of polyester covering of the Freestyle bioprosthesis is located below the porcine right coronary artery. If this is the case, the left and noncoronary sinuses may be excised such that the right noncoronary sinus is in the patient's left coronary sinus and the Freestyle left coronary sinus sits in the patient's right coronary sinus. The porcine right coronary sinus will then sit in the patient's noncoronary sinus. To facilitate this fit, the remnant of the right coronary ostium of the bioprosthesis should be excised and closed with 4-0 sutures. The needles used to accomplish this can then be driven through the wall of the patient's noncoronary sinus to obliterate this potential space.

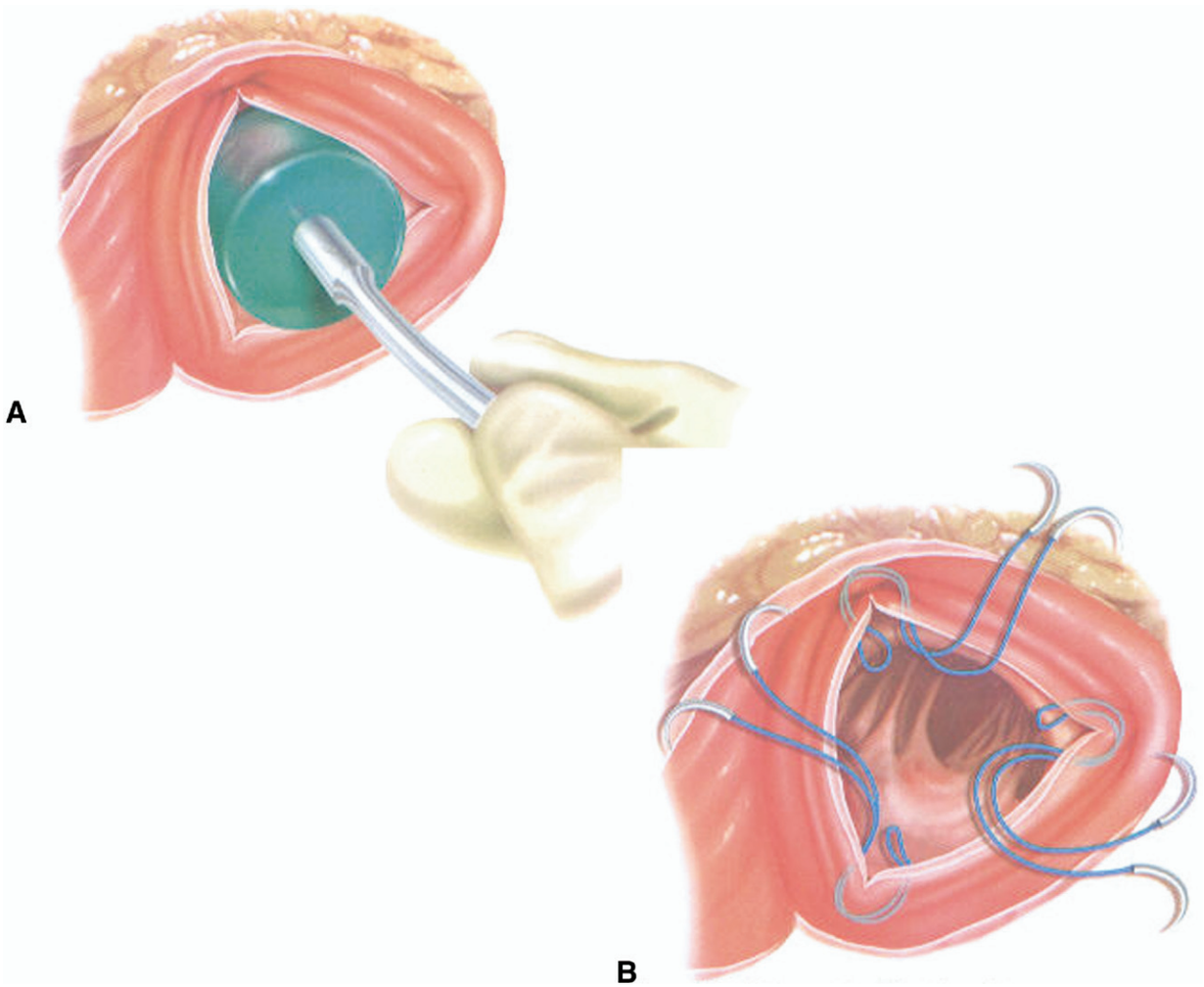


Figure 15 (A, B) If the patient's annulus measures larger than the largest available Freestyle valve, a subvalvular annuloplasty can be performed to reduce the circumference of the aortic wall. Using the Freestyle sizer as a guide for plication, a pledgeted "U" suture is placed at the base of the commissure. Either one, two, or all three commissures can then be plicated as necessary to reduce the annular diameter. If the sinotubular junction is larger than the largest valve but not greater than two valve sizes larger, the root inclusion technique can be performed to tailor the patient's sinotubular junction down to fit the crown of the Freestyle bioprosthesis. If the sinotubular junction is more than two valve sizes larger, the bioprosthesis should be implanted as a full root.

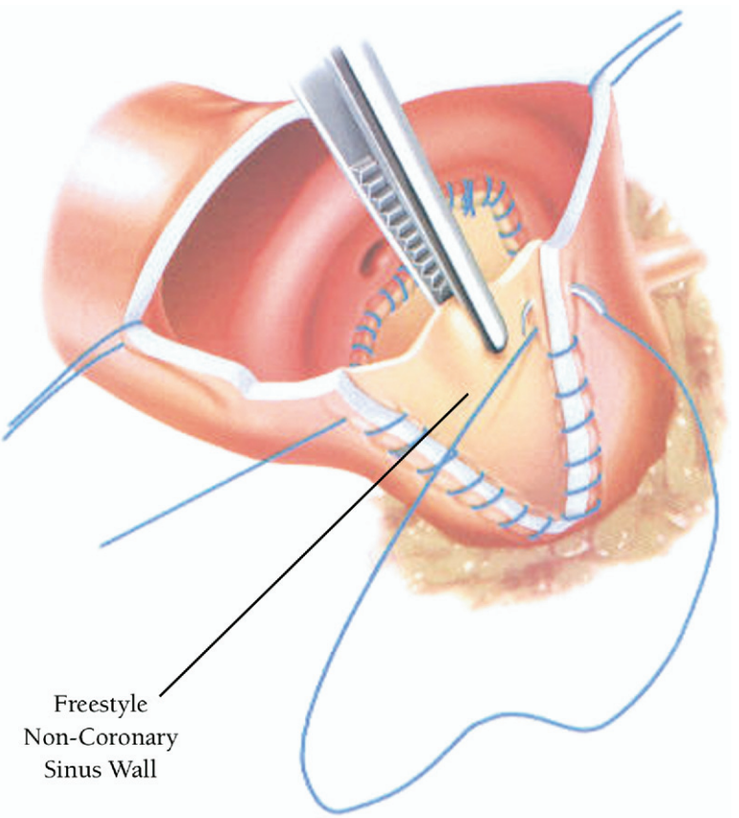


Figure 16 If the aortic root needs to be enlarged because the noncoronary wall of the bioprosthesis appears to buckle within the patient's aorta once the right and left coronary sinuses are secured, an incision into the non-coronary sinus can be made as shown in this figure and closed in a V-shaped fashion to the back wall of the bio-prosthesis.

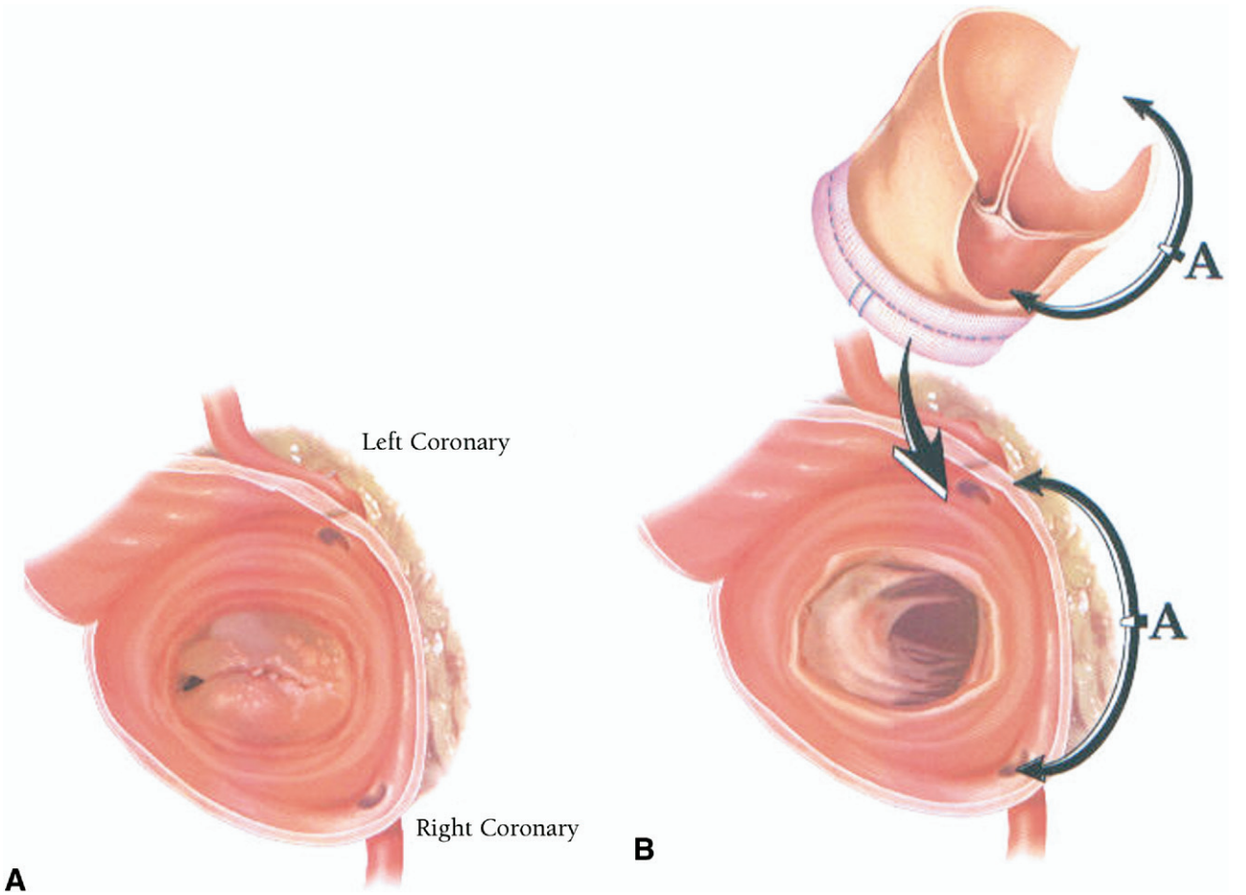


Figure 17 (A, B) In the patient with a bicuspid aortic valve in which both leaflets are of similar size, the left and right coronary ostia may be almost directly opposite one another. In this circumstance, after excising the diseased valve leaflets, one should determine the shortest distance between the left and the right coronary ostia. In most instances, the coronary ostia will not be quite 180° apart. The left–right commissural post of the Freestyle bioprosthesis should then be centered in the middle of the shortest distance between the right and left ostia. This will generally permit subcoronary implantation. If not, a full root technique should again be used.

Conclusions

The stentless valve used in a modified subcoronary technique is a more complex and time-consuming technique than implantation of a stented bioprosthesis. However, this prosthesis allows for upsizing of the replacement valve for a larger effective orifice area and improved hemodynamics. A stented bioprosthesis will also allow for better exercise response than a stented valve. Given these features, this is an excellent valve for patients with small roots or active patients who want superior exercise capabilities.